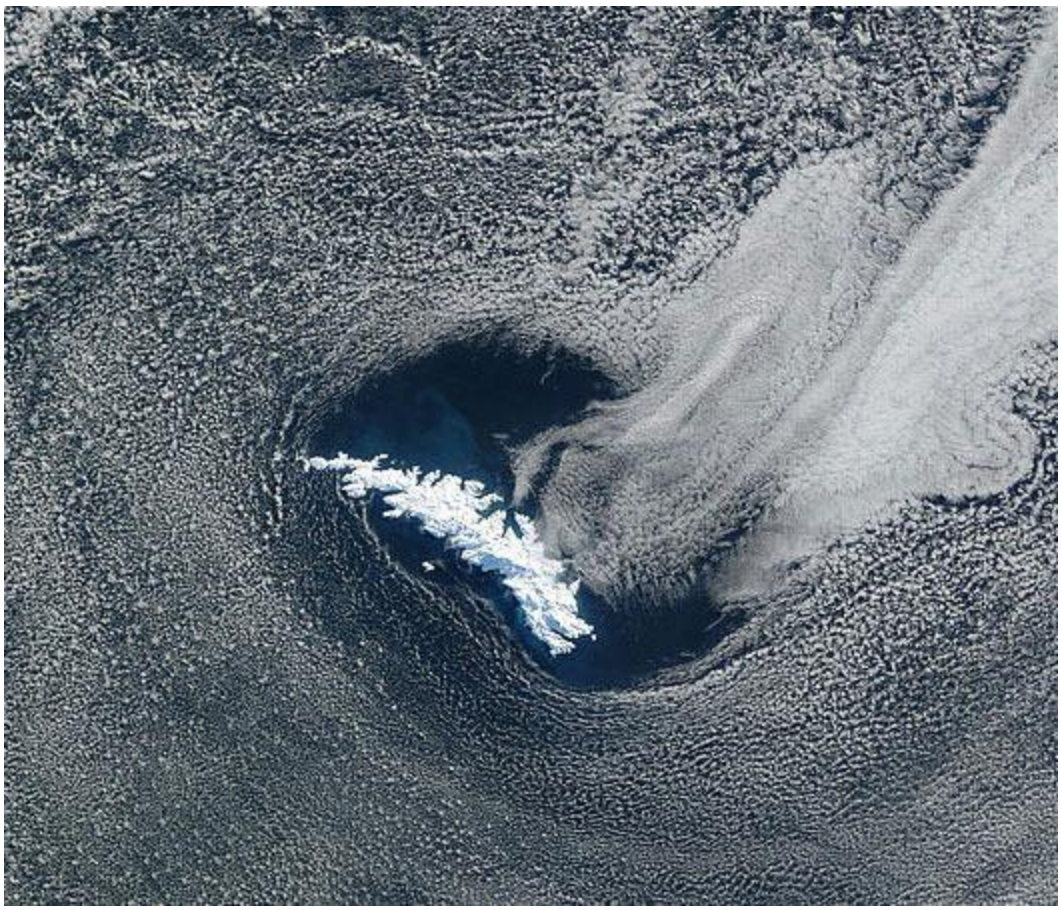
SCIENCE FOCUS: Ocean Circulation and Phytoplankton

South Georgia: A View Through the Clouds



MODIS image of South Georgia Island, acquired on August 8, 2002.

A short quiz: South Georgia is:

A) a region in one of the United States, famous for Vidalia onions;
B) the southern region of a small country at the eastern end of the Black Sea, whose capital city is Tbilisi;
C) a small and remote island in the far southern Atlantic Ocean; or
D) all of the above.

(Answer: D, "all of the above")

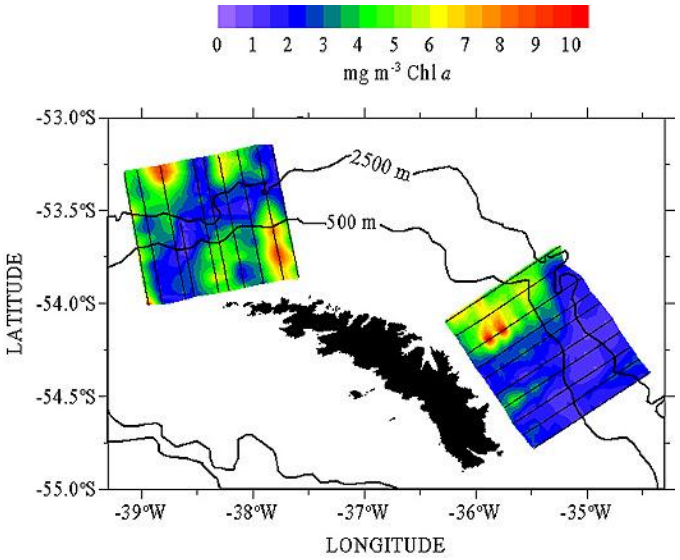
Even considering that some of us wax poetic about Vidalia onions, this *Science Focus!* article concerns South Georgia (C), the British territory in the southern Atlantic Ocean, which is shown in the remarkably clear MODIS image on the previous page. This image is remarkable, because for much of the year (particularly during the austral winter when this image was acquired) South Georgia is persistently covered by clouds. It's rare for spaceborne sensors to get a clear view of the island and its surrounding waters.

However, even if the view isn't clear, a quick visit to South Georgia would indicate that the waters around the island must be fairly productive. Large colonies of seals and seabirds breed at South Georgia and the region supports important commercial fisheries for krill and fish. In the past, the Antarctic fur seal and many species of whales were hunted to near extinction.

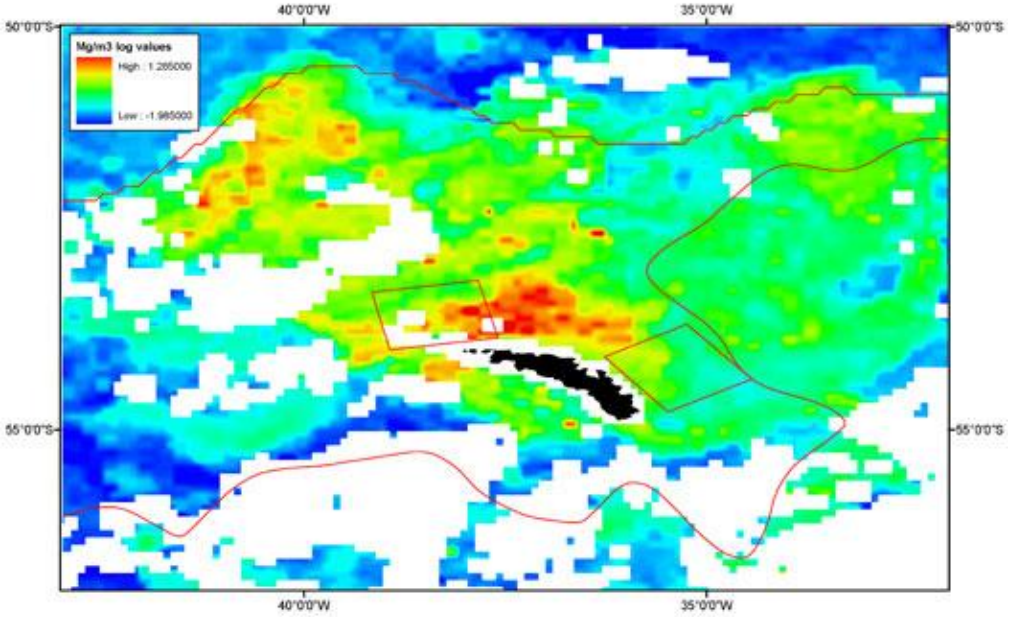
Here are just a few of South Georgia's king penguins:

The British Antarctic Survey conducted a number of research cruises to investigate why the waters around South Georgia are so productive. Large phytoplankton blooms around the island support the base of this food chain. However, in the remote Antarctic, shipboard surveys are restricted to relatively small areas and short time scales (icebergs and rough weather can also be a problem). It was only with satellite imagery, that the true size and extent of South Georgia's phytoplankton blooms could be appreciated.

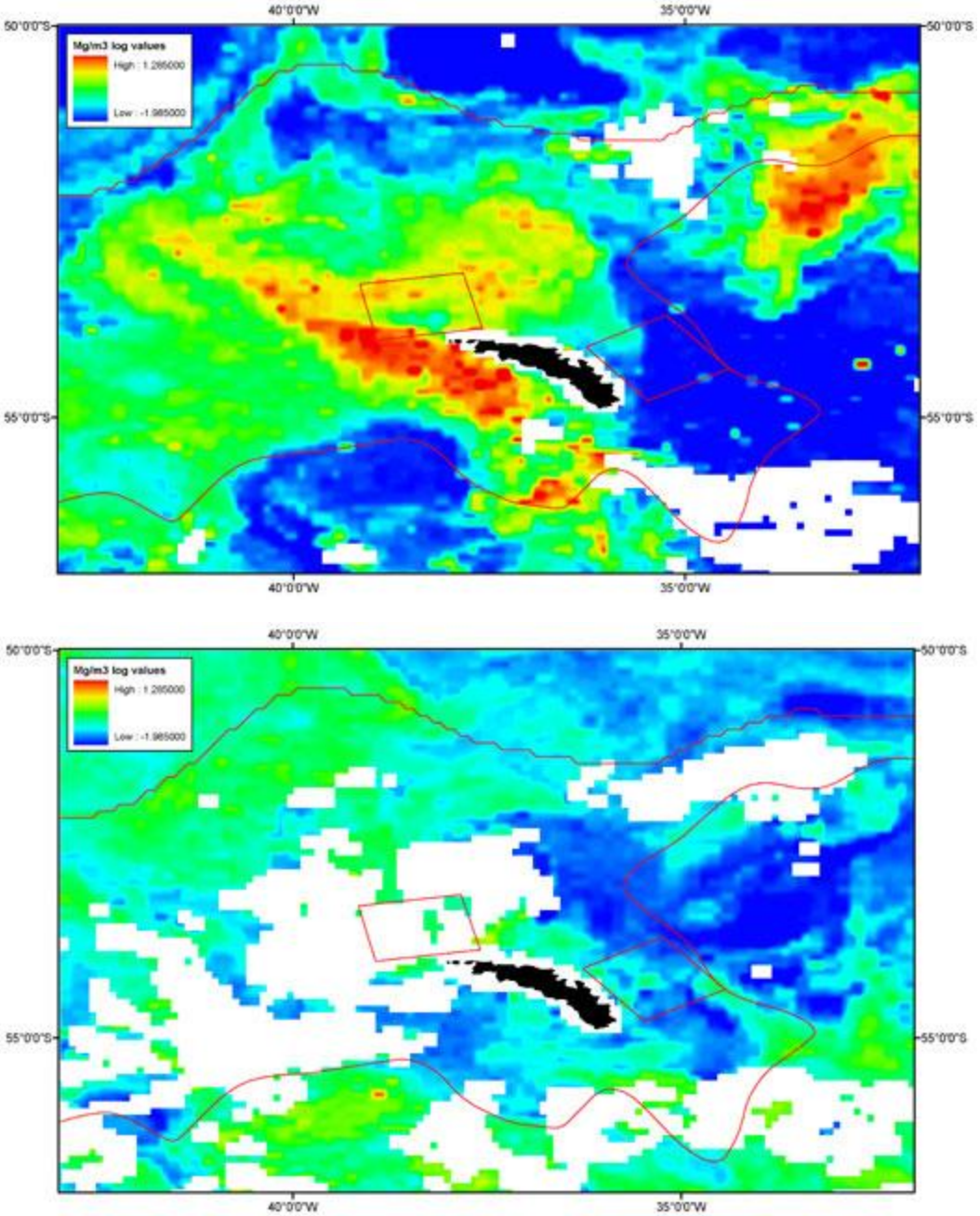
Data from SeaWiFS (using the spatial and temporal binning process that slowly clears clouds away through repeated observations) and British Antarctic Survey cruise data confirmed that waters to the northwest of South Georgia are generally the most productive. SeaWiFS also revealed that large blooms frequently occur to the south of the island, an area where few ship studies have taken place SeaWiFS revealed that South Georgia's blooms are highly variable, resulting in some seasons being far more productive than others. For example, large and persistent phytoplankton blooms to the northwest and south of the island were observed in January 2000 compared to the phytoplankton poor waters of January 1998.



Comparison of shipboard chlorophyll concentration measurements (top) and SeaWiFS chlorophyll concentrations during January 1999 (bottom). Note the size of the ship survey areas (rectangular boxes) in the SeaWiFS image.

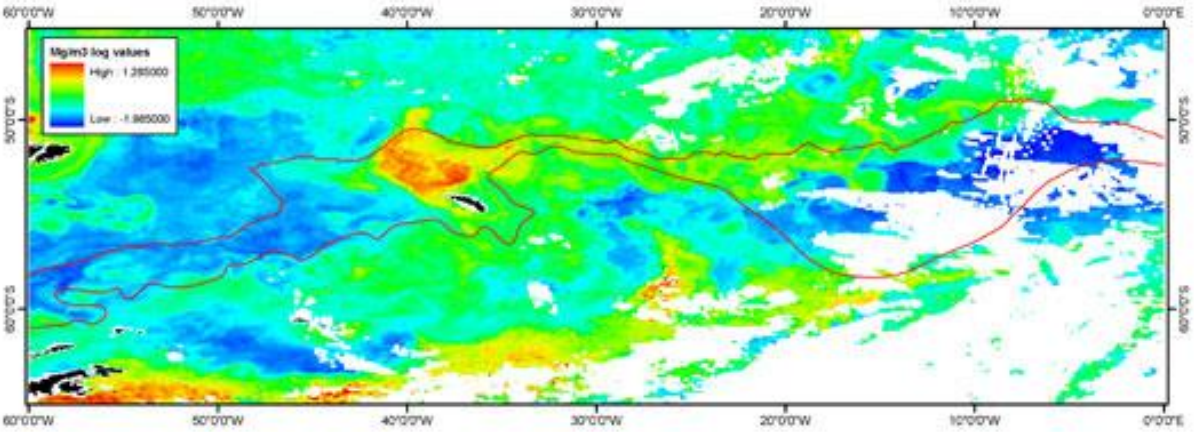


SeaWiFS data also indicated that phytoplankton blooms are regular occurrences both to the southwest and to the north of the island. At the height of phytoplankton activity, blooms can fill the entire area between South Georgia Island and the "Polar Front" of the Southern Circumpolar Ocean Current, which is an area of about 300 square kilometers. SeaWiFS also revealed that blooms can take place as early as October and as late as March, months when rough ocean conditions discourage scientific ships, and scientists, from routine research operations.



SeaWiFS data from January 2000 (above, showing southern extension of phytoplankton bloom), compared to January 1998 (below), when there was minimal phytoplankton productivity.

In addition, the satellite imagery revealed that phytoplankton growth around South Georgia was far higher than is typical for the Southern Ocean, and frequently extended considerable distances downstream from the island, towards the Polar Front and beyond (sometimes more than 2,750 km).



SeaWiFS chlorophyll concentrations during December 2001. The phytoplankton bloom extended several thousand kilometers to the east of South Georgia Island.

These widespread and long-lasting phytoplankton blooms are likely to have major consequences for secondary producers (e.g., krill and copepods that feed on phytoplankton), and in turn for seals and penguins that feed on krill, and highlight the South Georgia region's potential as a major carbon sink in the Southern Ocean. The next step is to gain a better understanding of the environmental dynamics that make this area such a productive place. Using SeaWiFS and MODIS ocean color data, it's possible to get a deeper, multi-level understanding of this marine ecosystem, just as it's possible to peel off the outer layers of an onion to reveal the tasty interior*.

*[The author begs the forgiveness of readers of this article, as he just had to include another reference to Vidalia onions.]

Acknowledgments

This Science Focus! article was written with the substantial assistance of Dr. Rebecca Korb and figures were produced by Andrew Fleming, both from the British Antarctic Survey.

Links

British Antarctic Survey

South Georgia Island

Living Edens: South Georgia Island (Public Broadcasting Service, USA)

South Georgia Island eco-system

Shackleton's Antarctic Adventure (PDF, Teacher's Guide to accompany film)